Japanese Patent Application, First Publication No. H02-212311
Date of First Publication: August 23, 1990

Japanese Patent Application No. H01-32606
Application Date: February 14, 1989

Title of the Invention: Method and Device for Dissolving Carbon Dioxide Gas

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Description

1. Title of the Invention

Method and Device for Dissolving Carbon Dioxide Gas

2. Claims

1. A method for dissolving carbon dioxide gas, wherein carbon dioxide gas is dissolved in a liquid jet stream used for dissolution by merging carbon dioxide gas into the liquid jet stream used for dissolution to obtain a merged carbon dioxide gas and jet stream and passing the merged carbon dioxide gas and jet stream through a diffuser and a static mixer in succession.

2. A method for dissolving carbon dioxide gas, wherein carbon dioxide gas is dissolved in a liquid jet stream used for dissolution having a gas other than carbon dioxide gas present by merging carbon dioxide into the jet stream used for dissolution having a gas other than carbon dioxide present to obtain a merged carbon dioxide gas

and jet stream, passing the merged carbon dioxide gas and jet stream through a diffuser and a static mixer in succession, and separating and removing the gas other than carbon dioxide from the merged carbon dioxide gas and jet stream.

3. A device for dissolving carbon dioxide gas, comprising a junction tube for merging a jet stream used for dissolution and carbon dioxide gas, a diffuser for influxing the liquid jet stream used for dissolution and carbon dioxide gas, and a static mixer, which is connected after the diffuser.

4. A device for dissolving carbon dioxide gas according to claim 3, wherein the diffuser and the static mixer are provided on the axis of the liquid jet stream used for dissolution.

3. Detailed Description of the Invention

(Field of Industrial Applicability)

The present invention relates to a method and a device for dissolving carbon dioxide gas to be used in the production of fluids including carbon dioxide gas, in particular, beer, cold beverages, and the like.

(Prior Art)

In the production of beer, cold beverages, and the like, a pinpoint carbonator or a carbo cooler was used to dissolve carbon dioxide gas in the liquid. In a pinpoint carbonator, a supply tube for carbon dioxide was connected partway along the circulation tube for the liquid used for dissolution and this connection part of the circulation tube for the liquid used for dissolution was provided with a drawing part such as a Venturi tube (made from sintered metal). The concentration of dissolved carbon dioxide gas is determined by a carbon dioxide gas sensor provided downstream of the connecting part and the amount of carbon dioxide gas supply could be adjusted according to this.

The carbo cooler has a cooling means, and is a gas-liquid contact wetted wall column provided with multiple layers of corrugated plates in a cooled tank. In the carbo cooler, carbon dioxide gas is injected in from the upper part of the tank and the carbon dioxide gas can be dissolved in the liquid used for dissolution by being brought into contact with the liquid used for dissolution under a high pressure (for example, Japanese Unexamined Patent Application, First Publication No. S58-43932 and Japanese Unexamined Patent Application, First Publication No. S58-116031).

(Problem to be Solved by the Present Invention)

Carbon dioxide gas absorption efficiency by conventional techniques is not sufficient and when production was increased, the carbon dioxide gas absorption step became a bottleneck in product manufacture.

The pinpoint carbonator has drawbacks that the amount of dissolved carbon dioxide gas is small and that the concentration of the dissolved carbon dioxide gas is unstable.

With respect to a carbo cooler, in order to increase handling capability, there are the basic drawbacks that a high pressure tank having a large volume is needed and there is a limit to the speed of high pressure dissolution. Also, there is the drawback that a difference occurs in the amount of carbon dioxide gas absorbed depending on the height of the liquid level.

Furthermore, in situations such as a carbo cooler where carbon dioxide gas dissolution must be carried out at a low temperature, the temperature of the liquid must be kept at a low temperature even in the bottling step for filling cans with the liquid having carbon dioxide gas dissolved therein. Also, after the bottling step, excess energy must be spent on a heat sterilization step to heat the outside of the cans.

An object of the present invention is to provide a method and a device for dissolving carbon dioxide gas to solve the problems of the above-mentioned prior art.

(Means for Solving the Problem)

In accordance with the present invention, the above-mentioned object can be achieved by the methods and the devices below.

A method for dissolving carbon dioxide gas, wherein carbon dioxide gas is dissolved in a liquid jet stream used for dissolution by merging carbon dioxide gas into the liquid jet stream used for dissolution to obtain a merged carbon dioxide gas and jet stream and passing the merged carbon dioxide gas and jet stream through a diffuser and a static mixer in succession.

A method for dissolving carbon dioxide gas, wherein carbon dioxide gas is dissolved in a liquid jet stream used for dissolution having a gas other than carbon dioxide gas present by merging carbon dioxide into the jet stream used for dissolution having a gas other than carbon dioxide present to obtain a merged carbon dioxide gas and jet stream, passing the merged carbon dioxide gas and jet stream through a diffuser

and a static mixer in succession, and separating and removing the gas other than carbon dioxide from the merged carbon dioxide gas and jet stream.

A device for dissolving carbon dioxide gas, comprising a junction tube for merging a jet stream used for dissolution and carbon dioxide gas, a diffuser for influxing the liquid jet stream used for dissolution and carbon dioxide gas, and a static mixer, which is connected after the diffuser.

Preferably, the diffuser and the static mixer are provided on the axis of the liquid jet stream.

(Operation of the Invention)

The carbon dioxide gas is firstly primarily mixed into the liquid jet stream used for dissolution in the junction tube for merging the liquid jet stream used for dissolution and carbon dioxide gas. The primarily mixed liquid gas stream and carbon dioxide gas are influxed in a diffuser such as a Venturi tube. By the time the carbon dioxide gas reaches the outlet of the diffuser, the carbon dioxide gas, which has become fine bubbles, is dispersed in the liquid jet stream. The contact area between the liquid and carbon dioxide gas becomes larger.

The static mixer is connected after the diffuser. When the liquid get stream reaches the outlet of the diffuser, the static mixer further disperses (divides), mixes, and agitates the carbon dioxide gas dispersed phase so that the carbon dioxide gas is quickly absorbed and dissolved in the liquid. Also, when a gas other than carbon dioxide gas is present in the liquid jet stream used for dissolution, along with the operation of absorbing and dissolving carbon dioxide gas, the concentration of dissolved oxygen and the like can be decreased at the same time.

When the diffuser and the static mixer are provided on the axis of the liquid jet stream used for dissolution, these are able to realize an even better operation and carbon dioxide gas can be absorbed and dissolved even more effectively.

(Preferred Embodiments)

Anything may be used as the junction tube, as long as the same can merge carbon dioxide gas and the liquid jet stream used for dissolution. A junction tube having at least one inlet for the liquid used for dissolution and at least one inlet for carbon dioxide gas, for example, a T-tube, a Y-tube, a cross-shaped tube, or the like, can be used. The outlet for the liquid gas stream used for dissolution in the junction part

of the junction tube can be a nozzle. Similarly, the outlet for carbon dioxide gas in the junction part can be a nozzle.

The diffuser may be provided directly after the position where the liquid jet stream and carbon dioxide gas are influxed. For example, it can be provided by being connected to the outlet of the junction tube, it can be provided in the junction tube, or it can be provided by the influxing tip of the diffuser being inserted into the junction tube so that the remaining part protrudes from the junction tube.

As the diffuser, a diffuser in which the inner diameter gradually becomes smaller from the inlet, has a narrowest part with a length at a uniform diameter, and an outlet which widens (Laval nozzle), a diffuser which does not have the narrowest part with a length at a uniform diameter, or the like can be used.

The static mixer conditions such as the bore diameter, the length, and the number of elements of the static mixer can be arbitrarily decided to optimize retention time by the flow amount and the physical properties (viscosity, density, temperature, and the like) of the liquid used for dissolution, the target concentration of dissolved carbon dioxide gas, or the like. The flow speed in the static mixer can be, for example, about 10 to 200 cm/s. Two or more static mixers having different diameters can be joined.

The connection part in the device for dissolving carbon dioxide gas of the present invention is preferably constituted of a material that is corrosion resistant and abrasion resistant or a sanitary tube material for food products (tube material used in food machine devices). For example, the nozzle part and the diffuser part of the junction tube can be a polyfluroethylene resin (Teflon) such as polytetrafluroethylene resin and the static mixer can be ceramic.

On the downstream side of the device for dissolving carbon dioxide gas of the present invention, a retention tank for the liquid having dissolved carbon dioxide gas is connected and microscopic fluctuations in the concentration of the dissolved carbon gas disappear. Therefore, an even more constant concentration of dissolved carbon dioxide gas can be obtained. As required, an agitating means may be provided.

The drawing in pressure of the carbon dioxide gas can be 3 to 7 atm (gauge pressure). As the retention tank, in accordance with the desired concentration and pressure of the generated liquid with dissolved carbon dioxide gas, a suitable low

pressure container or pressure resistant container can be used. However, a special high pressure container for dissolution is not required.

(Examples)

Example 1

The Examples of the device for dissolving carbon dioxide of the present invention will be explained using the drawings. Figure 1 is an abbreviated cross-sectional drawing in the flowing direction of the liquid jet stream used for dissolution in a device for dissolving carbon dioxide gas according to an embodiment of the present invention.

A junction tube 1 is a T-tube with its cross-section in the perpendicular direction of the flow path being circular.

A nozzle 2 is constituted so that the flow path area gradually decreases from the upstream part to the downstream part, the flow path becomes a minimum at the outlet, and the tip of the outlet is narrowly tapered. In a diffuser 3, the inner diameter gradually narrows from the inlet, decreasing the flow path. From the smallest part of the flow path, the flow path area gradually increases and is widest at the outlet. The cross-section in the perpendicular direction of the flow path of the nozzle 2 and the diffuser 3 is circular. The diffuser 3 is provided on the axis of the liquid jet stream used for dissolution injected from the nozzle 2.

The nozzle tip of the nozzle 2 protrudes from the junction part of the junction tube 1. The diffuser 3 is positioned downstream from the junction part of the junction tube 1.

The nozzle 2 is set in the inlet for introduction of the liquid used in dissolution in the junction tube 1 so as to be airtight. The diffuser 3 is connected by being set in the outlet of the junction tube 1 so as to be airtight. The nozzle 2 and the diffuser 3 are made from polyethylene fluoride resins. The outlet of the diffuser 3 and the inlet of a static mixer 4 (having a lining tube 5 made from a polyethylene fluoride resin) made from ceramic are connected so as to be airtight. In order to do this, a flange 1f on the outlet side of the junction tube 1 and a flange 4f on the inlet side of the static mixer 4 are fixed by screws and nuts. Thus, the desired static mixer can be easily changed and connected.

The inlet for introduction of carbon dioxide gas and the inlet for introduction of the liquid used for dissolution in the junction tube 1 and the outlet of the static mixer 4 have a flange with a hole H for bolt stopping and can be easily connected to the tubing.

The nozzle 2 and the junction tube 1 may be an integrated material. Also, the diffuser 3 may be connected further on the downstream side of the outlet of the junction tube 1.

Carbon dioxide gas is introduced into the junction tube 1 from an inlet for introducing carbon dioxide 1a. The liquid used for dissolution is introduced into the junction tube from an inlet for introduction of the liquid used for dissolution 2a of the nozzle 2. The liquid to be used for dissolution is injected from the outlet of the nozzle 2 and is joined and mixed with the carbon dioxide gas. When the mixture of the liquid to be used for dissolution and carbon dioxide gas reaches the outlet of the diffuser 3 it has become a liquid in which fine bubbles of carbon dioxide gas have been dispersed and when the same reaches the outlet of the static mixer 4, the carbon dioxide gas has been absorbed and dissolved in the liquid used for dissolution.

Example 2

A device for dissolving carbon dioxide gas according to the second embodiment of the present invention will be explained using Figure 2.

A device for dissolving carbon dioxide gas 20 has an inlet for introduction of the liquid used for dissolution 20a, an inlet for introduction of carbon dioxide gas 20b, and an outlet of the mixture of the liquid used for dissolution and carbon dioxide gas 20c. The inlet for the introduction of the liquid used for dissolution 20a connects to a tubing for the supply of the liquid used for dissolution A connected to a pump P via a check valve 29 and the liquid to be used for dissolution is supplied to the inlet for introduction of the liquid used for dissolution 20a. The inlet for the introduction of carbon dioxide gas 20b is connected to a tubing for supplying carbon dioxide gas B and carbon dioxide gas is supplied to the inlet for the introduction of carbon dioxide gas 20b. The tubing for supplying carbon dioxide gas B has a decompression valve 22, a thermometer T, a barometer 23, a flowmeter 24, a control bulb 25, an electromagnetic valve 26, a barometer 27, and a check valve 28.

The outlet of the mixture of carbon dioxide gas and the liquid for dissolution 20c has a barometer 30 and is connected to a tubing C for connecting to a static tank 21. The static tank 21 has a deaeration bulb 31 and a measuring instrument for measuring

the concentration of dissolved carbon dioxide gas 32 and is connected to a tubing D having bulbs 33 and 34. The static tank 21 is a retention tank for obtaining an even more uniform concentration of dissolved carbon dioxide gas in the mixture of carbon dioxide gas and the liquid used for dissolution. For example, retention is carried out every five minutes and the concentration of dissolved carbon dioxide can be made even more uniform. This concentration is measured by the measuring instrument for measuring the concentration of dissolved carbon dioxide 32. The control bulb 25 and the electromagnetic valve 26 of the tubing for carbon dioxide gas B are adjusted according to result of the measurement so that a liquid having dissolved carbon dioxide with a uniform concentration can be continuously prepared.

Also, instead of the static tank 21, a conventionally used carbo cooler such as a wetted wall column can be used in order to absorb and dissolve the carbon dioxide gas. However, in this situation, different to conventional carbon coolers, the temperature and pressure in the carbo cooler can be operated near room temperature and normal pressure.

Example 3

Carbon dioxide gas was dissolved in a liquid (water) using the device for dissolving carbon dioxide gas disclosed in the above-mentioned Example 1 of the present invention and a conventional carbo cooler. A static mixer having an inner diameter of 5 cm, a length of 114 cm, and 18 180°-rotational-elements was used. Carbon dioxide gas having a temperature of 10°C and a pressure of 3 to 5 kg f/cm^3 was supplied at an amount 500 to 800 N l/min to be mixed with and dissolved in water at 0 to 1°C, the water being pressure fed (pressure: 3 to 7 kg f/cm^3, amount sent: 100 to 180 l/min). The result being, carbon dioxide gas at a rate of 4 N l per each 1 l of liquid at 4°C was continuously dissolved when the rate of the liquid being sent was 100 to 180 l/min.

The conventional carbon cooler at 4 atm (gauge pressure) was only able to dissolve carbon dioxide gas at 1 N l for each 1 l of liquid at 4°C. However, the device of the present invention was able to dissolve 4 N l of carbon dioxide gas for each 1 l of liquid at 4°C.

Example 4

Using the device for dissolving carbon dioxide gas disclosed in the above-mentioned Example 1 of the present invention, carbon dioxide was dissolved in a liquid (water) having dissolved oxygen present at a concentration of 10 to 15 ppm.

A static mixer having an inner diameter of 2 cm, a length of 80 cm, and 24 180°-rotational-elements was used. Carbon dioxide gas at room temperature was supplied at a pressure of 5 to 7 atm (gauge pressure) at a rate of 10 N l/min, was mixed with and dissolved in water at room temperature which was pressure fed (pressure: 3 to 5 kg f/cm^3, amount sent: 23 l/min). The result being, a liquid having dissolved oxygen at a concentration of 1 to 3 ppm was obtained.

(Effect of the Invention)

In accordance with the method and device for dissolving carbon dioxide of the present invention, carbon dioxide gas can be effectively and constantly absorbed and dissolved in a liquid used for dissolution without the use of a dissolution pressure tank so that a liquid in which carbon dioxide gas is dissolved at a constant high concentration can be continuously and quickly prepared. There is no need for the mixture system to be at a high pressure, in particular, for the purpose of dissolution. Also, there is no need for a particularly low temperature like carbo coolers.

Accordingly, even when the production of carbonated beverages is increased, the step of absorbing carbon dioxide gas does not become a bottleneck in the production. Also, in the bottling step, there is no need to keep the temperature of the liquid low and can be operated near room temperature. Therefore, no condensation forms on the mouth or cap of the bottle and further, the amount of heat for heating can be saved in the heat sterilization step.

Also, the device for dissolving carbon dioxide of the present invention can separate and remove gases such as oxygen present in the liquid used for dissolution. Therefore, it can be used as a deaerator. The various conditions and steps which become a hindrance to the dissolution of oxygen can be applied (generation conservation in an anaerobiotic atmosphere).

Conventionally, the use of a static mixer per se was known simply for the purpose of mixing gases and liquids. However, in accordance with the present invention, a remarkable dissolution effect which cannot be compared to the effect expected by the conventional mixing of gases and liquids is achieved. This result is confirmed by the fact that compared to the carbo cooler high pressure dissolution

method, a dissolution having a concentration four times higher and not needing high pressure was obtained.

4. Brief Description of the Drawings

Figure 1 is an abbreviated cross-sectional drawing in the flowing direction of the liquid jet stream used for dissolution in a device for dissolving carbon dioxide gas according to an embodiment of the present invention.

Figure 2 is a flow diagram showing a device for dissolving carbon dioxide gas according to an embodiment of the present invention.

Concise explanation of Japanese Patent Application, First Publication No. H02-212311

It is disclosed that when a mixture of a liquid used for dissolution and carbon dioxide gas are influxed from the inlet side into a diffuser 3, wherein the inner diameter gradually narrows from the inlet, decreasing the flow path and the flow path area, which gradually increases from the smallest part of the flow path and is the widest at the outlet, and the mixture of the liquid to be used for dissolution and carbon dioxide gas reaches the outlet of the diffuser 3, it has become a liquid in which fine bubbles of carbon dioxide gas have been dispersed.

⑲日本国特許庁(JP) ⑪特許出願公開

⑫公開特許公報(A) 平2-212311

⑤Int. Cl.⁵ 識別記号 庁内整理番号 ㊸公開 平成2年(1990)8月23日

C 01 B 31/20 C 8821-4G
A 23 L 2/00 T 6926-4B
C 12 H 1/12 8114-4B

審査請求 未請求 請求項の数 4 (全5頁)

㊺発明の名称 炭酸ガス溶解方法及び装置

㉑特 願 平1-32606
㉒出 願 平1(1989)2月14日

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明 細 書

1. 発明の名称

炭酸ガス溶解方法及び装置

2. 特許請求の範囲

(1) 被溶解液体噴流に炭酸ガスを合流し炭酸ガス合流噴流を得，該炭酸ガス合流噴流をディフューザ及びスタティックミキサに順次通過させ該噴流に炭酸ガスを溶解させることを特徴とする炭酸ガス溶解方法。

(2) 炭酸ガス以外の気体が溶存する被溶解液体噴流に炭酸ガスを合流し炭酸ガス合流噴流を得，該炭酸ガス合流噴流をディフューザ及びスタティックミキサに順次通過させ，該炭酸ガス合流噴流から炭酸ガス以外の気体を分離除去し該噴流に炭酸ガスを溶解させることを特徴とする炭酸ガス溶解方法。

(3) 被溶解液体噴流及び炭酸ガスが合流する合流管と，該液体噴流及び炭酸ガスが流入するディフューザと，該ディフューザに後置接続するスタティックミキサとから成ることを特徴とする炭酸ガス溶解装置。

(4) 前記液体噴流軸上に前記ディフューザ及びスタティックミキサを配置したことを特徴とする請求項3記載の炭酸ガス溶解装置。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は，炭酸ガスを含有する液状体，特にビール，清涼飲料水等の製造に用いられる炭酸ガス溶解方法及び装置に関する。

(従来の技術)

ビール，清涼飲料水等の製造において炭酸ガスを液体に溶解させるため，ピンポイントカーボネータ又はカーボクーラが用いられていた。

ピンポイントカーボネータは，被溶解液体流通管の途中に炭酸ガス供給管を接合したものであって，該接合部の被溶解液体流通管にベンチュリー管等の絞り部を設けた(焼結金属製)ものである。該接合部より下流に設けた炭酸ガスセンサにより炭酸ガス溶解濃度を求め，それに応じて炭酸

ガス供給量を調節することもできる。

カーボクーラは，冷却手段を備え，冷却下にあるタンク内部に波板が多段に設けられた気液接触濡れ壁塔であり，タンク上部から炭酸ガスを吹込み，加圧下で被溶解液体と接触させることにより炭酸ガスを該液体に加圧溶解させる装置である（例えば特開昭58－43932号公報，特開昭58－116031号公報）。

（発明が解決しようとする課題）

従来の技術による炭酸ガス吸収効率は十分でなく，増産時には炭酸ガス吸収工程が製品製造のネックになっていた。

ピンポイントカーボネータでは，炭酸ガスの溶解量が少なくまたその溶解濃度が不安定であるという欠点を有する。

カーボクーラの場合，処理能力増大のためには，大容量の加圧タンクが必要であり加圧溶解速度に限界があるという基本的欠点がある。また，液面レベルの高低により炭酸ガスの吸収量に差が生ずるという欠点もある。

また，炭酸ガス溶解を低温で行なう必要のあるカーボクーラ等の場合には，炭酸ガス溶解液体をビンに詰めるボトリング工程でも該液体の温度を低く保たねばならず，その上ボトリング工程後のビン外側を加熱する加熱殺菌工程で余分なエネルギーを費やさねばならなかった。

本発明は上記従来技術の問題点を解決した炭酸ガス溶解方法及び装置の提供を目的とする。

（課題を解決するための手段）

本発明によれば次の方法及び装置により上記目的を達成できる。

被溶解液体噴流に炭酸ガスを合流し炭酸ガス合流噴流を得，該炭酸ガス合流噴流をディフューザ及びスタティックミキサに順次通過させ該噴流に炭酸ガスを溶解させることを特徴とする炭酸ガス溶解方法。

炭酸ガス以外の気体が溶存する被溶解液体噴流に炭酸ガスを合流し炭酸ガス合流噴流を得，該炭酸ガス合流噴流をディフューザ及びスタティックミキサに順次通過させ，該炭酸ガス合流噴流から炭酸ガス以外の気体を分離除去し該噴流に炭酸ガスを溶解させることを特徴とする炭酸ガス溶解方法。

被溶解液体噴流及び炭酸ガスが合流する合流管と，該液体噴流及び炭酸ガスが流入するディフューザと，該ディフューザに後置接続するスタティックミキサとから成ることを特徴とする炭酸ガス溶解装置。

好ましくは，液体噴流軸上にディフューザ及びスタティックミキサを配置する。

（作用）

被溶解液体噴流及び炭酸ガスが合流する合流管は，炭酸ガスを該液体噴流にまず一次混合させる。炭酸ガスの一次混合した該液体噴流はベンチュリ管等のディフューザに流入し，ディフューザの出口に達するまでには該液体噴流中に細かな気泡となった炭酸ガスが分散する。該液体と炭酸ガスの接触面積は大きくなっている。

スタティックミキサはディフューザに後置接続しており，ディフューザ出口に達した該液体噴流への炭酸ガス分散相を更に分散（分割），混合，攪拌し該液体に炭酸ガスを迅速に吸収溶解させる。また，被溶解液体噴流に酸素等の炭酸ガス以外の気体が溶存している場合は炭酸ガスの吸収溶解操作に伴って同時に溶存酸素等の濃度を低減することができる。

被溶解液体噴流軸上にディフューザ及びスタティックミキサが配された場合，これらはより一層の作用を発揮し該液体に炭酸ガスをより効果的に吸収溶解させることができる。

（好適な実施態様）

合流管は被溶解液体噴流及び炭酸ガスを合流させることができるものであればよく，少なくとも1つの被溶解液体入口及び少なくとも1つの炭酸ガス入口を有する合流管を用いることができ，例えばT字管，Y字管又は十字管等である。合流管の合流部の被溶解液体噴流出口はノズルにできる。同様に該合流部の炭酸ガス出口もノズルにできる。

ディフューザは該液体噴流及び炭酸ガスが流入

する位置の直後に設ければよく，例えば合流管の出口に接続して設けることができ，合流管の内部に設けることもでき，あるいはディフューザの流入先端部を合流管の内部に挿入し残りの部分を合流管から突出して設けることもできる。

ディフューザとしては，入口からしだいに内径が絞られ均一径で長さのある最狭部を有し出口が末広がりになったディフューザ（ラバール管），あるいは該均一径で長さのある最狭部を有さないディフューザ等を用いることができる。

スタティックミキサの口径，長さ，エレメントの数等のスタティックミキサの条件は，被溶解液体の流量及び物性（粘度，密度，温度等），あるいは目的とする炭酸ガス溶解濃度等により適宜決定し，滞留時間を最適にできる。スタティックミキサ内の流速は，例えば10～200cm／秒程度にできる。径の夫々異なる2以上のスタティックミキサを連結することもできる。

本発明の炭酸ガス溶解装置の接液部は，好ましくは耐蝕性及び耐摩耗性を有する材質あるいは食品用としてサニタリー配管材（食品機械装置用配管材）で構成する。例えば合流管のノズル部及びディフューザ部をポリテトラフルオルエチレン樹脂等のポリ弗化エチレン系樹脂（テフロン）にし，スタティックミキサ部をセラミックスにできる。

本発明の炭酸ガス溶解装置の下流側に炭酸ガス溶解液体の滞留槽を接続し，炭酸ガス溶存濃度の微視的なバラツキをなくし該濃度をより一層一定にできる。滞留槽の滞留時間は例えば5分間程度にできる。必要に応じ撹拌手段を設ける。

炭酸ガス吹込圧は3～7気圧（ゲージ圧）にできる。滞留槽としては，生成炭酸ガス溶解液の所要濃度及び圧力に応じ適当な微圧ないし耐圧容器を用いるが，溶解のための特別の高圧容器は必要としない。

（実施例）

実施例1

本発明の炭酸ガス溶解装置の実施例を図面により説明する。第1図は，本発明の一実施例の炭酸ガス溶解装置の被溶解液体が流れる方向の概略断面図である。

合流管1は，流路に対して直角方向の断面が円形のT字管である。

ノズル2は，流路の上流部から下流部に向って徐々に流路面積が減少し出口部分で最小流路面積になっており，出口先端部を絞った先細ノズルである。ディフューザ3は，入口からしだいに内径が絞られ流路面積が減少し，流路面積最小部からしだいに流路面積が増加して出口が末広がりになっている。ノズル2及びディフューザ3の流路に対して直角方向の流路断面は円形である。ディフューザ3は，ノズル2から噴射される被溶解液体噴流の軸上に配されている。

ノズル2は合流管1の合流部にノズル先端部を突き出している。ディフューザ3は合流管1の合流部より下流に位置する。

ノズル2は合流管1の被溶解液体導入口に気密にはめこまれている。ディフューザ3は合流管1の出口に気密にはめこまれて接続している。ノズル2及びディフューザ3はポリ弗化エチレン系樹脂製である。ディフューザ3の出口とセラミックス製のスタティックミキサ4（ポリ弗化エチレン系樹脂製ライニング管5を有する）の入口が気密に接続するように，合流管1の出口側のフランジ1fとスタティックミキサ4の入口側のフランジ4fがビス及びナットにより固定されている。そのため所望のスタティックミキサと容易に変更し接続することができる。

合流管1の炭酸ガス導入口部，被溶解液体導入口部及びスタティックミキサ4の流出口部もボルト止め用の孔Hが穿たれたフランジを有し，配管との接続が容易である。

なお，ノズル2と合流管1は一体化した部材であっても良く，またディフューザ3は合流管1の出口のさらに下流側に接続していても良い。

炭酸ガスは合流管1の炭酸ガス導入口1aから合流管1に導入される。被溶解液体はノズル2の被溶解液体導入口2aから合流管1に導入される。被溶解液体はノズル2の出口から噴射され

炭酸ガスと合流し混合する。被溶解液体と炭酸ガスの混合物は、ディフューザ3の出口に達すると炭酸ガスの細かな気泡が分散した液体になり、スタティックミキサ4の出口に達すると該液体は炭酸ガスを吸収溶解している。

実施例2

本発明の炭酸ガス溶解装置の第2実施例を第2図により説明する。

炭酸ガス溶解装置20は被溶解液体導入口20a，炭酸ガス導入口20b及び炭酸ガス溶解液体流出口20cを有する。被溶解液体導入口20aは、逆止弁29を介してポンプPに連なる被溶解液体供給配管Aと接続し該導入口20aには被溶解液体が供給される。炭酸ガス導入口20bは炭酸ガス供給配管Bと接続し該導入口20bには炭酸ガスが供給される。該配管Bは、減圧弁22、温度計T、圧力計23、流量計24、コントロールバルブ25、電磁弁26、圧力計27及び逆止弁28を有する。

炭酸ガス溶解液体流出口20cは、圧力計30を有し静置タンク21に接続する配管Cと接続する。静置タンク21はエアー抜きバルブ31及び炭酸ガス溶解濃度測定器32を備え、バルブ33及び34を有する配管Dと接続する。静置タンク21は、炭酸ガス溶解液体の炭酸ガス溶解濃度をより一層均一にするための滞留槽であり、例えば5分間程度滞留させ該濃度をより一層均一にできる。この濃度は該測定器32によって測定でき、この測定結果に応じて炭酸ガス供給配管Bのコントロールバルブ25及び電磁弁26を調整し溶解濃度の均一な炭酸ガス溶解溶液を連続的に製造できる。

また、静置タンク21のかわりに、炭酸ガスの吸収溶解のために従来使用されていた濡れ壁塔様のカーボクーラを代用できる。但し、この場合カーボクーラ内の温度、圧力は、従来のカーボクーラとは異なり、常温、常圧に近くして運転できる。

実施例3

前記本発明の実施例1に示す炭酸ガス溶解装置及び従来のカーボクーラの夫々を用いて液体（水）に炭酸ガスを溶解させた。内径5cm×長さ114cm×180°ねじりエレメント数18枚のスタティックミキサを用い、温度0～1℃の水をポンプで圧送（圧力3～7kgf/cm²，送量100～180ℓ/min）し、圧力3～5kgf/cm²，温度10℃の炭酸ガスを500～800Nℓ/min送気して、混合・溶解させた。その結果，4℃の液1ℓ当り4Nℓの炭酸ガスを送液量100～180ℓ/minのレートで連続溶解できた。

従来のカーボクーラでは4気圧（ゲージ圧），4℃の炭酸ガスは液1ℓ当り1Nℓしか溶解しなかったが，本発明の装置によれば4℃の液1ℓ当り4Nℓの炭酸ガスを溶解できた。

実施例4

前記本発明の実施例1に示す炭酸ガス溶解装置を用いて，溶存酸素濃度10～15ppmの液体（水）に炭酸ガスを溶解させた。

内径2cm×長さ80cm×180°ねじりエレメント数24枚のスタティックミキサを用い，温度室温の水をポンプで圧送（圧力3～5kgf/cm²，送量23ℓ/min）し，圧力5～7気圧（ゲージ圧），温度室温の炭酸ガスを10Nℓ/min送気して，混合・溶解させた。その結果溶存酸素濃度1～3ppmの液体を得ることができた。

（発明の効果）

本発明の炭酸ガス溶解方法及び装置によれば，溶解加圧タンクを用いることなく被溶解液体に炭酸ガスを効率よくかつ一定に吸収溶解させ，炭酸ガスを一定の高濃度で溶存する液体を連続してかつ迅速に製造できる。混合系は特に溶解の目的で高圧にする必要がなくまたカーボクーラ等の如く特別の低温にする必要もない。

従って炭酸飲料製品を増産する場合でも炭酸ガス吸収工程は製品製造のネックにならない。また，ボトリング工程で液温を低く保つ必要がなく常温近くで運転できるので，ビンの口や王冠部に結露が生じず，さらにボトリング工程後の加熱殺菌工程での加熱熱量の節約もできる。

さらに，本発明の炭酸ガス溶解装置は，酸素等の溶存ガスを被溶解液体から分離除去できるので，デエアレータとしても使用できる。酸素の溶存が障害となる様々な条件，工程（嫌気性液状培

囲気の生成保持）にも応用出来る。

従来，一般に単に気液混合の目的でスタティックミキサを用いること自体は知られていたが，本発明によれば，従来の気液混合の作用から期待される単なる混合の効果とは比較にならない顕著な溶解効果が得られた。その効果はカーボクーラの高圧溶解法に比し4倍もの高濃度の溶解が高圧にすることなく達成されたことにより如実に立証される。

4．図面の簡単な説明

第1図は本発明の一実施例の炭酸ガス溶解装置の被溶解液体が流れる方向の概略断面図，第2図は本発明の炭酸ガス溶解装置の実施例を示すフロー図である。

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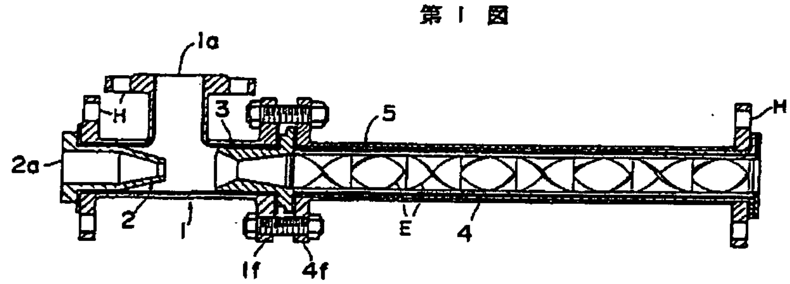
第1図



第2図